Linda S. Adams
Secretary for Environmental Protection

Air Resources Board

Mary D. Nichols, Chairman
1001 I Street • P.O. Box 2815
Sacramento, California 95812 • www.arb.ca.gov

Arnold Schwarzenegger
Governor

TO: CALIFORNIA ENERGY COMMISSION
Attention: Docket No. 07-BSTD-1
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FROM: Peggy L. Jenkins, Manager
Indoor Exposure Assessment Section
Air Resources Board

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SUBJECT: COMMENTS ON THE PROPOSED 2008 BUILDING VENTILATION STANDARDS IN TITLE 24 [Sections 121, 125, and 150], DOCKET NO. 07-BSTD-1

We fully support the California Energy Commission's efforts to improve the energy efficient design of California's buildings while maintaining healthy indoor air quality (IAQ). Our specific comments on the draft ventilation standards and acceptance requirements for nonresidential and residential buildings are given below. The recommended changes are intended to achieve enforceable requirements for reliable building ventilation.

NONRESIDENTIAL BUILDINGS

1. Sec. 121.b.1, Natural Ventilation exemption. We recommend requiring that natural ventilation systems be engineered to provide sufficient outdoor air ventilation and thermal comfort. Design demonstration should include documentation of system performance through accepted engineering methods of calculating air flows and thermal conditions. The standards should also require a low-noise exhaust fan to provide back-up or supplemental ventilation when needed.

   Natural ventilation is often an unreliable method of providing adequate ventilation and thermal comfort.[1, 2] This recommended approach is consistent with that used in

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[1] Walker A, 2006. Design Guidance: Natural Ventilation. National. Renewable Energy Laboratory. Whole Building Design Guide. National Institute of Building Sciences, Washington, DC. http://www.wbdg.org/design/naturalventilation.php, updated March 13, 2006
[2] Emmerich SJ, Persily AK, Dols WS, Axley JW, 2003. Impact of Natural Ventilation Strategies and Design Issues for California Applications, Including Input to ASHRAE Standard 62 and California Title 24. Building and Fire Research Laboratory, National Institute of Standards and Technology, Gaithersburg,

American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) 62.1-2004[3], the latest version of Best Practices Manual Design Criteria for the Collaborative for High Performance Schools (CHPS, 2006),[4] and good engineering practices.[5] Best practices for natural ventilation design include building ridges perpendicular to the summer wind direction, narrow buildings, and the number and location of supply openings and exhaust openings engineered to optimize cross-flow and convective currents.

2. Sec. 121.b.2, Air filter design. The standards should require a pressure gauge installed across the air filter, with a mark installed on the gauge to indicate the manufacturer specifications for filter replacement. This would promote proper maintenance, since air filters are often poorly maintained. This measure is considered best practice and is inexpensive. Wording of the regulation should be similar to that in the Cal/OSHA requirements for exhaust systems in workplaces.[6]

3. *Ibid*. For nonresidential buildings that will be or are expected to be near major sources of outdoor pollutants, the standards should include requirements for high efficiency filters such as those with a MERV 13 rating. A low-efficiency pre-filter is also recommended as a means of reducing filter replacement costs. Additional information on how to identify and mitigate impacts from nearby roadways and other major pollutant sources outdoors is available in the Air Resources Board's land use guidelines.[7]

4. Sec. 121.c.3.C, Exemption 3, Demand Control Ventilation (DCV) exemptions. The standards should also exempt nail salons explicitly from DCV requirements. Nail salons produce fumes and often lack effective exhaust ventilation; DCV would only worsen this situation.

5. Sec. 121.c.4, DCV controls. The results of a recent pilot study by Fisk *et al*.[8] suggest that DCV system maintenance and/or accuracy may be inadequate in systems that are as little as two years old. The standards should specify that the

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MD. Prepared for Architectural Energy Corporation. NISTIR 7062. http://fire.nist.gov/bfrlpubs/build03/PDF/b03063.pdf.

[3] ASHRAE (American Society of Heating, Refrigerating, and Air-Conditioning Engineers), 2004. ANSI/ASHRAE Standard 62.1-2004,Ventilation for Acceptable Indoor Air Quality. Atlanta, GA.

[4] Collaborative for High Performance Schools (CHPS), 2006. Best Practices Manual, Vol. III, Criteria, Indoor Air Quality Minimum Requirements, EQ 2.0.1. http://www.chps.net/manual/documents/BPM_2006_Edition/CHPS_III_2006.pdf.

[5] Walker A, 2006. *Op cit*.

[6] http://www.dir.ca.gov/title8/5143.html.

[7] ARB. 2005. Air Quality and Land Use Handbook: A Community Health Perspective. http://www.arb.ca.gov/ch/handbook.pdf.

[8] Fisk WJ, Faulkner D, Sullivan DP, 2006. Accuracy of CO_2 sensors in commercial buildings: a pilot study. Lawrence Berkeley National Laboratory, Indoor Environment Department, Berkeley, CA. http://repositories.cdlib.org/cgi/viewcontent.cgi?article=5019&context=lbnl.

DCV controls have a fail-safe mode so that sensor malfunction or failure will not result in extreme under-ventilation. For rooms that have highly variable occupant density, the ventilation rate in failure mode should be at least that for the average occupant density, rather than a minimum ventilation setting. This fail safe feature is apparently a common design feature in DCV systems, and would address major failures of the DCV sensors.[9] In addition, there should be a manual override to adjust ventilation rates properly until the sensor can be replaced or repaired. These requirements should also be included in the Acceptance Requirements.

6. Sec. 121.c.4.D, DCV outdoor CO_2 assumption. We recommend requiring an outdoor CO_2 sensor rather than assuming a certain outdoor level of CO_2. If the option of assuming outdoor CO_2 levels is retained, we recommend increasing the assumed outdoor CO_2 level to 500 ppm, and reducing the allowable increment from 600 ppm to 500 ppm. This would help avoid the under-ventilation of buildings, and provide an incentive for using an outdoor sensor for situations where outdoor CO_2 levels may be lower. This measure should also be verified through Acceptance Requirements.

   This recommendation is based on the outdoor CO_2 levels measured at 49 schools across California in the California Portable Classrooms Study.[10] In this study, the outdoor levels were often well above 400 ppm. The median 1-hour average CO_2 levels from 8 AM to 2 PM were 410-494 ppm, and 95%ile values were 496-530 ppm. We would expect similar outdoor levels near office buildings and other types of commercial buildings, and even higher levels near nonresidential buildings in highly urbanized areas.

7. Sec. 125, DCV acceptance requirements. The draft Acceptance Requirements (Nonresidential Appendix, NA7.5.5) adequately cover all the operational modes, but the specific procedure for testing multiple sensors is not clear. The wording should be modified to require testing of each sensor, especially since the current manufacturing quality in the sensors appears to be inconsistent.[11]

8. Sec. 125,a.1, and Appendix NA 7.5.1, Verification of ventilation rates in occupied spaces. The proposed standards would require measurement of total outdoor air flows, presumably at the outdoor air intake. We recommend also requiring testing and balancing of air flows at supply registers, which can have low flows because of improper installation or design. This requirement is necessary to reduce under-

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[9] PECI (Portland Energy Conservation, Inc.), 2006. Control System Design Guide. See Sec. 3.4.1 and Sec. 3.3. http://www.peci.org/ftguide/csdg/CSDG.htm.

[10] Whitmore R, Clayton A, Akland G, 2003. California Portable Classrooms Study, Phase Ii: Main Study, Final Report, Volume Ii, Appendix F. ARB Contract No. 00-317. Prepared for California Air Resources Board, Sacramento, CA and California Department of Health Services, Berkeley, CA. RTI International, Research Triangle Park, NC. Results are weighted to adjust for different probabilities of selection for each school. http://www.arb.ca.gov/research/indoor/pcs/pcs-fr/pcs_v2_ph2_app_f-h_03-23-04.pdf.

[11] Fisk *et al*., 2006. *Op cit.*

ventilation, improve thermal comfort, and facilitate compliance with Cal OSHA regulations (Title 8, Sec. 5142). This type of testing is already done routinely in most new buildings, and was included under the air balancing requirements in Section 121(f) of the 2001 standards.

RESIDENTIAL BUILDINGS

9. Sec. 150(o), Ventilation for Indoor Air Quality, Reference to ASHRAE 62.2-2007. The Standard needs to specify the 2007 version that is incorporated by reference. In addition, the Initial Statement of Reasons indicates that the 2004 version is referenced – this needs to be corrected to the 2007 version.

10. Appendix RA, Acceptance Requirements for Mechanical Ventilation (MV) Systems. In a study of 160 energy-efficient homes in the Pacific Northwest, most of the MV systems did not provide ventilation at the rated capacity due to system design and installation flaws.[12] Because the MV system is an essential health and safety feature in new homes, and because this technology is relatively new to California builders and homeowners, we recommend the following measures:

    a) Appendix RA3 – Residential Field Verification and Diagnostic Test Procedures. We recommend acceptance testing and inspection of MV systems to verify adequate air flows, filter installation, control system performance, duct design, accessibility, and controls labeling. Flow measurements are proposed acceptance requirements for residential HVAC systems (Appendix RA 3.1, Residential Field Verification and Diagnostic Test Procedures).

    b) MV Maintenance. The standards should require that MV systems have a maintenance contract for at least the first few years. This type of approach is used as a Performance Target in DOE's Building America Program. MV systems add a new level of complexity to residential HVAC systems, which can make it very difficult for homeowners and renters to operate and maintain the system properly. We have heard of cases in California where occupants do not know how to operate the MV system and leave it off, or do not change the filter.

    c) Implementation Training. We recommend mandatory training on MV system requirements for designers, builders, and inspectors to quickly get them up to speed, at least for the first few years of standard implementation. For example, the State of Washington carried out extensive training of builders and contractors, and they produced manuals with explicit installation instructions and

[12] Palmiter, L., T. Bond, I. Brown, and D. Baylon, April 28, 1992. "Measured Infiltration and Ventilation in Manufactured Homes; Cycle II." Ecotope, Inc., Seattle, WA. http://ecotope.com/pubframe.html.

diagrams.[13] Such training could be done online to reduce the time and inconvenience.

The following comments refer to sections in ASHRAE 62.2-2007, which is incorporated by reference in the standard. In addition, all of these items should also be verified through the Acceptance Requirements.

11. Sec. 4.4, Delivered Air. For exhaust-only MV systems, we recommend requiring that the central air system must cycle periodically to improve air distribution. Ontario Province in Canada requires this feature.[14]

12. Sec. 4.3, Control and Operation. ASHRAE does not require kitchen exhaust systems to have a means of ensuring effective operation. We recommend requiring an automatic control of range hood and oven exhausts, such as a burner interlock or heat sensor.

13. Sec. 5, Local Exhaust. The standards should include specific design requirements for exhaust duct design such as the number of bends, insulation level, and screen mesh size. For an example, see the State of Washington's Ventilation and IAQ Code and Builders Field Guide.[15,16]

14. Sec. 6.2, Instructions and Labeling. We recommend specifying very clear and visible labeling with user instructions. The ASHRAE 62.2 appendices give some guidance on the labeling of control systems, but this is not part of the official standard. The Washington standards and manual also have useful examples.

15. Sec. 6.4, Combustion and Solid-Fuel Burning Appliances.

    a) We recommend that the standards include measures to reduce pressure imbalances in the home, such as undercuts of room doors, transfer registers above room doors, and additional return ducts in distant parts of the house. This is considered best practice in high-performance, healthy home design. Excessive depressurization can cause IAQ problems by drawing in air pollutants from adjacent areas such as the garage, the crawl space, and the sub-slab area, or by drawing in cold air that causes warm moist air from the home to condense in wall spaces.

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[13] Washington State Ventilation and Indoor Air Quality Code, 2003 edition, and 2004 Builders Field Guide, Ch. 8, Ventilation. http://www.energy.wsu.edu/code/code_support.cfm

[14] Fugler D, 2004. Analysis of Ventilation System Performance in New Ontario Houses. Research Highlight. Technical Series 04-117. Canada Mortgage and Housing Corporation, Ottawa, Ontario. http://www03.cmhc-schl.gc.ca/b2c/b2c/mimes/pdf/63615.pdf.

[15] Washington State Building Code Council, 2007. Washington State Ventilation And Indoor Air Quality Code (2006 Edition). Section 303, and Table 3-3, Prescriptive Exhaust Duct Sizing. http://www.energy.wsu.edu/documents/code/wsec2006/VIAQ2006.pdf.

[16] Washington State University Extension Energy Program, 2004. WSEC Builder's Field Guide 6th Edition. Chapter 8: Ventilation. http://www.energy.wsu.edu/documents/code/bfg/2004/chapter8_2004.pdf.

b) The standards should not allow exhaust-only systems in homes with open hearth fireplaces. This measure would avoid depressurization and backdrafting problems. Such as measure is required by the State of Minnesota building standards. Open hearth fireplaces have become less common in low-elevation regions of California in recent years, but they are still allowed in nearly all parts of California and are found in many remodeling or addition projects.

16. Sec. 6.6, Minimum Filtration.

a) Air filtration for the mechanical ventilation system is required to have a MERV rating of at least 6, but air filtration is only required if the duct length is over 10 feet. We recommend filtration for all MV systems in order to reduce transport of outdoor dust and allergens into the interior spaces of buildings.

b) We recommend specifying minimum requirements for filter access. For example, filter access should not require a ladder, and space clearance should be sufficient to easily replace a filter.

Thank you for the opportunity to have input on the revisions to the building energy efficiency standards for California. If you have any questions or need further information, please contact me at (916) 323-1504 or mjenkins@arb.ca.gov, or you may contact Tom Phillips at (916) 322-7145 or tphillip@arb.ca.gov.

cc: Bill Pennington, Office Manager
Building and Appliance Office
California Energy Commission, MS-25
1516 9th Street
Sacramento, California 95814-5504

Mazi Shirakh, P.E., M.B.A.
Senior Mechanical Engineer
Technical Lead, Building Energy Efficiency Standards
Building and Appliance Office
California Energy Commission, MS-25
1516 9th Street
Sacramento, California 95814-5504

Tom Phillips
Staff Air Pollution Specialist
Research Division
Air Resources Board

bcc: Bart Croes, RD
Richard Corey, RD
Linda Smith, RD
Chron: RD, HEA

Marla Mueller
Technical Lead, Air Quality Research Program
PIER Environmental Area
California Energy Commission
1516 Ninth Street, MS-43, IMS F1
Sacramento, California 95814-5512

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